

CALIFORNIA DEPARTMENT OF EDUCATION
REGIONAL OCCUPATIONAL CENTER AND PROGRAMS
UNIT

STATEWIDE COURSE APPROVAL

NIMS PRECISION MACHINING

June 2001

The ROCP Unit of the California Department of Education has joined with the Metalworking Industry to cooperatively develop a ROCP - 2000 statewide course outline for certification and to facilitate standards based curriculum design. Statewide course approvals allow ROCPS automatic certification for the first year of operation. After the first year, normal operational requirements will apply. This course, "NIMS Precision Machining" is developed using skill standards developed by the non-profit National Institute for Metalworking Skills, Inc. organization. An Ad Hoc Advisory Committee composed of educators and industry representatives met to work out details. The standards based outline is modular and has been designed for implementation with school schedules varying from 180 hours to 1080 hours annually. Program certification will be a part of the implementation strategy. Academic and essential employability skills are integral to the curriculum design and Cooperative Education and Community Classroom instructional methodologies will be encouraged.

NIMS CERTIFICATION PROGRAM

What is NIMS?

The National Institute for Metalworking Skills, Inc. (NIMS) is a national nonprofit organization formed in 1995 to support the development of a skilled workforce for the metalworking industry. NIMS support is accomplished through four programmatic activities: (1) developing, writing, validating, and maintaining skill standards for each industry within metalworking; (2) certifying programs that instruct to the skill standards and meet NIMS quality requirements; (3) credentialing the skills of individuals against the skill standards through performance and written assessments; and (4) assisting states, schools, and companies to form partnerships to implement the skill standards, achieve program certification, and credential trainees and workers.

Who Organized NIMS?

A consortium of metalworking trade associations, national labor organizations, a council of state governors, companies, and educators, created NIMS. The consortium began the process of developing skill standards and credentialing assessments in late 1992.

Why Certify Educational Training Programs to NIMS Standards?

NIMS programs bring together educators, companies, and workers and define through skill standards the skills and competencies the metalworking industry wants and needs. Skill standards also provide educators with a valuable tool to maintain, develop, and update their curricula. NIMS certification status will provide educational institutions with a powerful advertising tool for attracting new enrollments as well as increasing placement of graduates. Student achievements can be certified through the nationally recognized credentialing program with standards accepted and promoted by the metalworking industry.

How Will This Work for Your Program?

Provides a tool to assist in developing, maintaining, and updating your curriculum with a structured career pathway and career advancement opportunities for students. An opportunity to provide the metalworking industry with better focused and prepared students using school-industry partnerships. An advertising tool to help increase enrollment in career preparation program and aid in placing graduates. Students can earn credentials in skill standards that are recognized nationwide.

How Do the NIMS Programs Work?

NIMS requirements focus on accuracy, consistency, safety, knowledge, problem-solving, individual competence yet team participation, and demonstrated performance. These qualities foster productivity. When individuals earn credentials and receive recognition, self-esteem and pride in workmanship are boosted and morale is increased. By demonstrating that students can earn nationally recognized credentials program success is enhanced.

As schools organize their curricula to bring students to meet standards and earn credentials, employers have greater assurance in knowing the job applicant's ability level. The credential can be matched to the skill standards regardless of the program the applicant has attended because the skill standards and credentialing requirements are the same nationwide.

What Is a NIMS Credential?

A NIMS credential is recognition that a person's competencies have been validated against a set of industry-written skill standards. Skill validation involves meeting the performance requirements and passing a knowledge skills examination required for the credential. The performance requirements and examination are the same nationwide. Therefore, the credential is portable.

Credentialing requirements are set for groupings of job duties and thus are modular. Taken as a whole, the credentialing modules define a career path within a metalworking industry and in many cases across metalworking processes. This helps schools counsel students about opportunities and communicates to individuals that skill and knowledge acquisition in metalworking is a continuing endeavor.

What Does Program Certification Involve?

The purpose of certifying the metalworking program is to improve the quality of instruction and foster partnerships between educators and industry. NIMS sets standards for program content; equipment, tooling, and measuring devices inventory; instructor qualifications; and participation by advisory bodies. A self-evaluation form focusing on NIMS desired program content must be completed. The school must also complete an on-site evaluation of their training program, facilities, instructors, and administration. NIMS does not specify curriculum or endorse curricular products, and does not provide metalworking training.

What Is the Process for ON-Site Evaluations?

NIMS forms a review team that will make a two-day on-site evaluation. The first day is usually spent reviewing the facilities, reviewing noted documentation, observing students at work, and interviewing instructors and administrators. The second day involves interviews with employers in the program area, interviews with advisory committee members, and final discussions with instructors and administration.

COURSE OUTLINE

Date: June 20, 2001

Course Title: **NIMS Precision Machining**

Total Course Hours: 1080-variable

CBEDS Title: Machine Tool Operation

CBEDS# 5607

Job Title(s):	D.O.T.	TITLE	D.O.T.	TITLE
	600.280-034	Machinist Apprentice	605.380-010	Numerical Control Operator
	601.682-10	Tool Dresser	605.685-030	Milling Machine Operator
	604.380-26	Turret Lathe Operator	606.682-014	Drill Press Operator
	604.685-026	Engine Lathe Operator	607.682-010	Cut-Off Saw Operator

Pre-requisites: 16 years of age or junior in high school

Course Description:

This standards-based course provides students with the ability to become credentialed in metalworking skill areas that are nationally recognized and are portable. The two level program is certified by the National Institute for Metalworking Skills, Inc. In Level I, students will learn core tool and machining skills in three major areas; basic bench operations, basic metal cutting operations, and basic inspection and quality assurance functions. In Level II, students will learn more complex machining skills along with Computer Numerical Control (CNC) principles, angular measurements, and additional auxiliary equipment. Integrated throughout the course are career preparation standards, which include communication, interpersonal skills, problem solving and skills necessary to seek and keep a job.

Industry-based internships in state-of-the-art machining facilities, both paid and non-paid are an integral part of the program design with summer and school year participation. Youth organizations will provide technological and leadership skills as a part of the class activities.

Hours

Class Ind

Course Outline:

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A. ORIENTATION

- Demonstrate knowledge of course outline.
- Demonstrates awareness of course objectives and competencies.
- Introduction to math problems related to the metalworking industry.
- Introduce the value of participation in youth organizations.

B. ESSENTIAL EMPLOYABILITY SKILLS/CAREER PREPARATION/SCANS SKILLS

a. ATTITUDES AND BEHAVIOR

The learner will:

- demonstrate promptness and attend class regularly
- demonstrate appropriate personal grooming and dress
- follow instructions

Course Outline:

b. HUMAN RELATIONS

The learner will:

- practice courtesy, develop and maintain acceptable working relations with peers, and demonstrate respect for position of sponsor/supervisor and demonstrate a positive cooperative attitude

c. JOB SEARCH SKILLS

The learner will:

- prepare a written inventory of personal data or resume
- locate job opportunities through use of want ads, placement agencies or journals
- visit at least two facilities related to area of training and observe jobs performed
- complete a job application correctly
- prepare for and critique a simulated employment interview
- discuss employee benefits and rights as related to the specific occupational job area including gender equity and equal opportunity employment
- identify acceptable procedures to leave a job

d. PORTFOLIO PREPARATION

The learner will:

- prepare a finished professional portfolio of best projects

e. FOUNDATION - SECRETARIES COMMISSION ON ACHIEVING NECESSARY SKILLS (SCANS)

The learner will:

- perform basic computations and approaches to practical problems by choosing appropriately from a variety of mathematical practices
- recognize problems and devise and implement a plan of action
- assess self accurately, set personal goals, monitor progress, and exhibit self-control

C. CONTENT SKILL AREAS

a. SAFETY

The learner will receive safety instruction through oral, visual, tactile and cognitive methodologies. This should include, but not be limited to, paper/computer testing, lecture and demonstrations. Learners will perform oral examination, proper sequence of operations and will differentiate between safe and unsafe practices.

The learner must demonstrate safe practices on all equipment through successful performance on written and verbal tests (matrixed examinations), and real time demonstrations to the instructor (tools, equipment, materials). Examination preparation activities will include reading, writing, technical explanations (verbal) and demonstration techniques.

Course Outline:

The learner will:

- demonstrate knowledge of classroom procedures and earthquake, fire, and emergency drills
- know and demonstrate proper safety procedures for equipment
- satisfactorily complete a written safety exam
- demonstrate safe practices on all equipment through application
- demonstrate knowledge and understanding of handling hazardous materials
- demonstrate interpretation of Material Safety Data Sheets (MSDS's) in shop environment
- describe employee accident procedures

b. LEGAL CONSIDERATIONS

The learner will:

- demonstrate ethical responsibility
- understand loss prevention/shrinkage from internal theft and inventory loss
- identify and protect against robbery and suspected theft
- understand the consequences of theft, loss, and misuse of property

c. LEADERSHIP SKILLS

The learner will:

- display appropriate professional behavior via initiative, creativity, self-control, interest/enthusiasm
- demonstrate leadership skills by working independently, making appropriate decisions, working well with others and taking constructive criticism

1.0 CONTENT COMPETENCIES - LEVEL I

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1.1 Module 1 Task Planning and Management

Designed to allow the student hands-on skill advancement in task planning and management. Emphasis will be on part process planning and all work necessary to produce route and process sheets.

Task Process Planning: Develop a process plan for a part requiring milling, drilling, turning, or grinding. Complete an operation sheet detailing the process plan and required speeds, feeds, depth of cuts, and coolant needs.

Performance Standard: Given a detail drawing of a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies including the required speeds and feeds, depth of cuts and coolant needs, depth of cuts, and coolant needs. Make a 5 to 15 minute presentation explaining each of the process plan steps to be taken, identify all major components and functions of the machine tools, and all major hand tools, measuring tools, tools and surface finishes, materials, and provide the rationale for the selected speeds and feeds, depth of cuts and coolant needs.

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2.1 Module 2 Manual Operations

Designed to provide basic skills needed for using hand tools and performing benchmetal work. Included is the use of arbor presses, work holding and hand tools, hacksaws, files, reamers, taps and dies, finishing tools, bushings, bearings and assembly tools.

2.1.1 Manual Operations: Benchwork - Tap holes. Use files, scrapers, and coated abrasives to deburr parts. Use arbor presses to perform interference fits. Use bench vises and hand tools appropriately.

Performance Standard: Given a process plan, a drawing, access to hand tools, a newly machined part with holes prepared for tapping, a hole prepared for press fit of a bushing, and a stud for one tapped hole, deburr the part, tap the holes, press in the bushing, install the stud, and saw the stud to the length specified.

2.2.0 Manual Operations: Layout

Designed to provide basic skills for laying out hole locations, radii and surfaces to match the drawing and specifications. The student is required to perform all work necessary to produce the part given the raw material, drawing, process plan, layout tooling and measuring instruments.

Manual Operations: Layout - Layout the location of hole centers and surfaces with an accuracy of +/- .015.

Performance Standard: Given a surface plate, surface gage, layout height gage, combination set, scribe, layout ink, prick punch, ball peen hammer, process plan, and drawing, layout hole locations, radii, and surfaces matching the specifications.

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3.1 Module 3 Turning Operations

Designed to provide basic skills needed for operating standard engine lathes. Given access to an appropriate turning machine and accessories, raw material, process plan, drawing, precision measurement and cutting tools, practices necessary to produce a part are required.

3.1.1 Turning Operations: Between Centers Turning - Setup and perform straight turning operations between centers.

Performance Standard: Given raw material, process plan, drawing, hand, precision, and cutting tools, and access to an appropriate engine lathe and its accessories, produce a part matching the process plan and the drawing specifications using appropriate trade practices, safety procedures, speeds and feeds, depth of cuts and coolant needs. The specified part should have at least three diameters within $\pm .001$, and Unified National Coarse (UNC) external thread, one Unified National Fine (UNF) external thread, and require an end-for-end swap.

3.1.2 Turning Operations: Chucking – Setup and perform chucking operations for turning.

Performance Standard: Given access to a appropriate engine lathe and its accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications using proper trade practices and speeds and feeds, depth of cuts and coolant needs. The specified part should have at least three diameters within $\pm .005$, one bore within $\pm .005$, and UNC external and one UNF internal thread, and require at least two chuckings or other work holding setup. The part shall be repositioned at least one time during the machining operation.

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4.1 Module 4 Milling Operations

Designed to provide basic skills needed for operating standard vertical and horizontal milling machines. All work is required to produce a part given raw material, process plan, drawing, tooling, and measurement instruments.

4.1.1 Power Feed Milling: Setup and operate a horizontal or vertical milling machine using power speeds and feeds, depth of cuts and coolant needs. Perform routine milling.

Performance Standard: Given access to an appropriate milling machine and its accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications. The specified part should require squaring up from the raw state, and require significant material removal. Depth of cuts between .200" and .250" will be required.

4.2.1 Vertical Milling: Set up and operate vertical milling machines. Perform routine milling, and location of hole centers within $\pm .005$ ".

Performance Standard: Given access to an appropriate milling machine and its accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications using proper trade practices, speeds, feeds, depth of cuts, and coolant needs. The specified part should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within $\pm .005''$ and have three steps controlled by tolerances of $\pm .005''$.

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5.1 Module 5 Surface Grinding Operations

Designed to introduce the basic operations of a standard surface grinder. Requirements are to (1) select, mount, and dress a grinding wheel and (2) produce a part given a block squared on a mill, a process plan, drawing, hand and precision measuring tools.

5.1.1 Surface Grinding, Grinding Wheel Safety - Ring test grinding wheels, perform visual safety inspection, mount and dress a grinding wheel in preparation for surface grinding.

Performance Standard: Given a selection of wheels in various conditions determine which are suitable for use, mount one on the spindle, and dress it in preparation for surface grinding.

5.2.1 Surface Grinding, Horizontal Spindle, Reciprocating Table: Setup and operate manual surface grinders with a 10" and smaller diameter wheel. Perform routine surface grinding, location of surfaces, and squaring of surfaces. Perform wheel dressing.

Performance Standard: Given a block squared up on a mill, a process plan, drawing, hand and precision tools, choice of grinding wheels, access to a surface grinder and its accessories, dress the wheel, produce a part matching the process plan and drawing specifications using proper trade practices. The specified part would be in the semi-finished state having been squared. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

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6.1 Module 6 Drill Press Operations

Designed to introduce the basic operation of standard sensitive and power feed presses. Requirements are to produce a part given the raw material, process plan, drawing, tooling and measuring instruments.

6.1.1 Drill Press: Setup and operate drill presses. Perform routine drill press operations.

Performance Standard: Given access to a drill press and its accessories, a semi-finished part, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications. The specified part would be in the semi-finished state having been squared up and the outer surfaces completed with four center-drill locations. Finishing the part will require finishing of the four center-drilled locations and layout of a fifth location. Each hole must have at least two secondary operations. The secondary operations will consist of reaming, spot facing, countersinking, counterboring, and counterdrilling. At least one hole must be a blind hole and one a through hole. The fifth hole, a through hole, must have its location center punched, center drilled and finished from the layout. The fifth hole will be power tapped.

6.2.1 Power Saw Operation

Setup and operate power saws for cutoff operations.

Performance Standard:

Given a length of bar stock, a process plan, drawing, hand and basic measuring tools, and a power saw with an appropriate blade installed, cut a length of material matching the cut list on the process plan.

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7.1 Module 7 Quality Control, Inspection, and Process Adjustment

Designed to provide skills needed for basic inspection of machined parts and the process control, adjustment, and improvement of the machining processes used to manufacture those parts. Emphasis will be on teamwork, quality control, and continuous improvement. All participants will be required to work as team members and prove or disprove their suggestions.

7.1.1 Part Inspection: Develop an inspection plan and inspect simple parts using precision tools and practices. Prepare reports on the compliance of the parts.

Performance Standard: Given the necessary task process sheets for a part and verbal instructions, identify and select the required measuring instruments and conduct the required inspection procedure(s). Complete required written inspection report and make a decision to accept or reject component parts. Provide brief verbal explanation of inspection procedures, results, and decisions.

7.2.1 Process Control: Follow a sampling plan. Inspect the samples for the required data. Enter the data on appropriate charts. Graph the data. Respond to the warning conditions indicated by the process charts.

Performance Standard: Given access to an appropriate milling machine and its accessories, raw material, process plan, drawing, hand, precision, and cutting tools. produce a part matching the process plan and the drawing specifications using proper trade practices and speeds and feeds, depth of cuts and coolant needs. The specified part should require squaring from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within $\pm .005''$ and have three steps controlled by tolerances of $\pm .005''$. Geometric tolerancing practices should be included in the process.

- 7.3.1 Participation in Process Improvement:** As a member of a process team, analyze the performance of a production process. The team shall formulate process adjustments for improvements where appropriate. When appropriate, notify supervisor of the proposed adjustments and/or improvements. Where authorized, perform the strategies for process adjustment and/or improvement.

Performance Standard: As a team member that has been given a process plan, drawing, inspection process plan, verbal instructions, the necessary tools and equipment, and a routine production process having a problem(s), analyze the problem(s), propose remedies, obtain authorization to implement the process improvement(s), and produce the object. Perform the cause and effect analysis by participating in the development of a fishbone diagram with the team. Explain the fishbone diagram, the corrective actions and the reasoning connecting the fishbone root cause analysis to the remedial actions taken.

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8.1 Module 8 General Maintenance

An introduction to all issues involved in the general housekeeping, preventative maintenance and tooling maintenance in the metalworking field. Demonstration of appropriate actions regarding benchwork and layout areas, conventional lathe areas, Computer Numerical Control (CNC) machine areas, and the general facility is required. Specific maintenance of machines and tooling will be required along with preventative maintenance procedures.

- 8.1.1 General Housekeeping and Maintenance:** Keep workstations clean and safe. Keep tools, workbenches, and manual equipment clean, maintained, and safe.

Performance Standard: Given maintenance, cleaning, and housekeeping check lists, as well as verbal instructions, clean, maintain, and respond appropriately to safety hazards on all benchmetal work tools, conventional and CNC machine tools. Maintain cleanliness of the general work area.

Course Outline:

8.1.2 Preventative Maintenance, Machine Tools: Inspect and assess the general condition of an assigned machine tool. Make routine adjustments as necessary and as authorized. Report problems to supervision that are beyond the scope of authority. Perform daily, weekly, and/or monthly routine upkeep chores cited on checklists for a given machine tool.

Performance Standard: Given the preventative maintenance procedures and schedules for a given machine tool, as well as sufficient instruction and experience to recognize maintenance problems, Perform routine maintenance, report problems which are beyond the scope of authority, complete maintenance history forms. Make an oral presentation explaining the condition of the machine and the actions taken.

8.1.3 Tooling Maintenance: Inspect and assess the condition of tooling. Refurbish tooling where appropriate. Refer tooling for repair or regrind where appropriate.

Performance Standard: Given samples of tooling in various conditions, diagnose the tooling, take the correct steps to place tooling back in service. Sample tooling should include turning, milling, drilling and grinding tools. The tools should be both, insert tooling and conventional tooling. The technician must demonstrate the offhand grinding of a drill between the diameter of .125" and 1.000". The offhand regrinding of a turning tool and the correct rotation and replacement of inserts in an insert style milling cutter body must be demonstrated. The technician must demonstrate the ability to recognize a cutting tool that needs reconditioning or sharpening on a tool and cutter grinder.

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9.1 Module 9 Industrial Safety and Environmental Protection

Designed to introduce safety procedures used in the handling of work materials, operation of machines and tooling, and the handling and storage of hazardous wastes. Requirements are to demonstrate safe workplace practices given written and verbal instructions.

9.1.1 Machine Operations and Material handling: Perform assigned responsibilities while adhering to safe practices in accordance with Occupational Safety Health Administration (OSHA) requirements and guidelines. Document safety activities as required.

Performance Standard: Given written and verbal safety instructions and checklists based on OSHA requirements and guidelines, demonstrate safe workplace practices in material handling, machine operations handling of tooling, handling and application of coolants, cutting fluids and lubricants. Orally explain the actions taken which directly or indirectly bear upon safe practice in the execution of duties.

- 9.1.2 Hazardous Materials Handling and Storage:** Handle and store hazardous materials as assigned while adhering to safe practices in accordance with OSHA and Environmental Protection Act (EPA) requirements and guidelines. Document safety activities as required.

Performance Standard: Given written and verbal safety instructions detailing the handling and storage of hazardous materials in compliance with OSHA and EPA requirements and guidelines, demonstrate safe workplace practices in the identification, handling, and storage of hazardous materials.

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10.1 Module 10 Career Management and Employee Relations

Designed to introduce career opportunities and functions of the metalworking industries. The Learner will develop a career plan and an understanding of organizational structures and employment relationships. Interviewing skills and team skills will be practiced.

- 10.1.1 Career Planning:** Develop and explain a short-term career plan and resume.

Performance Standard: Given written information, presentations, and informational interviews with industry representatives on career opportunities in the metalworking industry, develop a short-term career plan (1-4 years) including career objectives, training and education, and employment opportunities. Develop a resume appropriate for the metalworking industry based on the career plan. Make an oral presentation of the career plan and resume.

- 10.1.2 Job Application and Interviewing:** Complete job application form and demonstrate interviewing skills.

Performance Standard: Given a job description and a standard application, complete the application form. Identify and demonstrate appropriate interviewing skills in an interview with a company representative.

- 10.1.3 Teamwork and Interpersonal Relations:** Demonstrate appropriate interpersonal skills in job performance evaluations, group communication and decision-making, and conflict resolution.

Hours
Class Ind

Course Outline:

Performance Standard: Given written and oral information about a machining technician in a work unit, demonstrate appropriate interpersonal skills in three simulated cases involving a supervisor or team leader and other team members: (1) receiving feedback on job performance in a formal evaluation process, (2) actively participating in a group decision-making process involving appropriate communication and feedback skills with other team members, and (3) resolving conflicts with supervisors and team members.

10.1.4 Employment Relations: Understand and explain employment rights and responsibilities in metalworking companies.

Performance Standard: Given written and verbal information on employment rights and responsibilities (similar to those contained in employee handbooks), answer questions about hiring and promotion requirement, dismissal and layoff policies, compensation schedules and amounts, and substance abuse policies.

180 11.1 Module 11 Industry Experience
Expand knowledge and experiences working in a machining/manufacturing environment utilizing cooperative education and/or community classroom methodologies.

360 180

Level I Classroom/ Hours: 360
Level I Industry Hours: 180

Total Level I Course Hours 540

30 1.0 CONTENT COMPETENCIES – LEVEL II

1.1 Module 1 Job Planning and Management

Designed to allow hands-on skill advancement. Emphasis will be on part process planning and capability studies. Development of a working knowledge in part routing and process planning sheets is required. Participation as a team member in capability studies using and interpreting statistical data is required.

1.1.1 Job Process Planning: Write a detailed process plan that includes a quality plan for a part requiring milling, drilling, turning, or grinding. Produce an operation sheet detailing the process plan and required speeds, feeds, depths of cuts, and coolant needs. Provide sketches as needed.

Performance Standard: Given a drawing detailing a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies to manufacture the part and write a detailed process plan including the quality plan for that part. Provide sketches as needed. Make a presentation explaining each of the process plan steps to be taken, identify all major components and functions of the machine tools, and all major hand tools, measuring tools, tools and fixtures, work materials and provide the rationale for the selected speeds and feeds, depth of cuts and coolant needs.

- 1.1.2 Participate in Capability Studies:** Participate as a team member in a capability study. Perform the required statistical calculations to support the capability study. With the assistance of the team leader prepare the necessary shop reports for the capability study.

Performance Standard: Given needed capability studies, and the data collected to satisfy the needs of that study, participate as a team member in support of the study. With the direction of the team leader, provide all the machining expertise and statistical calculation needed to satisfy the requirements of the capability study.

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2.1 Module 2 Manual Operations

Designed to provide hands-on skill advancement in layout practices and operations. Emphasis will be on bolt hole circles, location of surfaces related by non-right angles, and points of tangency. Practices necessary to layout a part given raw material, process plan, drawing, tooling, and measuring instruments are required.

2.1.1 Layout Bolt Circles, Angles, Tangency Points, Line Profiles:

Setup and layout bolt circles, locations of surfaces related by non-right angles, locations of points of tangency between arcs and lines, and profiles of a line which are non-arc based.

Performance Standard: Given a surface plate, surface gage, layout height gage, combination set, scribe, layout ink, prick punch, ball peen hammer, process plan, and drawing, layout a block of material that includes a flange face fixture with a 12 hole bolt circle, two examples of tangent radii, one a fillet, the other an external radius and defined profile of a line with approximating arcs and their coordinates supplied.

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3.1 Module 3 Band Saw Operation

Designed to provide hands-on skill advancement in the operations of standard band saws. Emphasis of this module will be on contour band sawing and blade welding. Practices necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments are required.

Course Outline:

- 3.1.1 Contour Band Sawing:** Set up and perform contour sawing according to the layout. Choose and mount appropriate blades. Weld, break, and re-weld blades as necessary.

Performance Standard: Given a part with a finished layout and access to an appropriate band saw and blades, finish saw the part according to the layout.

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4.1.0 Module 4 Turning Operations

Designed to provide hands-on skill advancement in lathe operations. Produce outside and inside diameter tapers, using a taper turning attachment, production turning, and turning between centers.

- 4.1.1 Turning Operations, Between Centers Taper Turning:** Set up and perform operations between centers turning for straight and tapered turning by offsetting the tailstock.

Performance Standard: Given access to an appropriate turning machine and its accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications using proper trade practices, speeds, feeds, depth of cuts, and coolant needs. The specified part should have at least two straight diameters within $\pm .001$ ", an appropriate taper at each end of the part, and require an end-for-end reversal of the part.

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5.1 Module 5 Milling Machine Operations

Designed to provide hands-on skill advancement in the operations of standard horizontal milling machines. Produce a part when given the raw material, process plan, drawing, tooling, and necessary measuring instruments.

- 5.1.1 Horizontal Milling, Square Up a Block:** Set up and perform squaring six surfaces of a block to within a $\pm .002$ " and $.002$ " over 4" tolerance.

Performance Standard: Given an appropriate milling machine and its accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and drawing specifications. The part will require being squared from the raw state.

- 5.1.2 Horizontal Mill, Cut a Key Seat:** Set up and perform milling key seats on a shaft.

Performance Standard: Given an appropriate milling machine and its accessories, raw material, process plan, drawing, hand, precision and cutting tools, produce a part matching the process plan and the drawing specifications using proper trade practices, speeds and feeds, depth of cuts and coolant needs. The specified part would require milling two key seats whose characteristics match the American National Standards Institute (ANSI) B17.1 keys and key seat standards.

- 5.1.3 Horizontal mill, Cut a Deep Slot with a Stagger Tooth Cutter:** Set up and perform the cutting of a deep slot using a stagger tooth cutter.

Performance Standard: Given access to an appropriate milling machine and its accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications. The specified part will require milling three deep slots, two parallel to one another, and a third at right angles to the first two.

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6.1 Module 6 Milling Attachment Operations

Designed to provide skill advancement in the operations of standard vertical milling machines. Emphasis will be to introduce common milling attachments and their use. Use of rotary tables, dividing and boring heads will be understood in detail. Perform tasks necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments.

- 6.1.1 Vertical Milling, Precision Location of Holes:** Set up and perform boring for location, size, and finish.

Performance Standard: Produce three bores to specification. The part will specify 3 holes in a 1" plate. The holes will be between $\frac{3}{4}$ " and 1-1/2" to locations within $\pm .0005$ ". One hole is to be counterbored to a decimal depth holding $\pm .002$ " and counterbored diameter within $\pm .005$ ".

- 6.1.2 Vertical Mill, Use Rotary Tables:** Set up and perform the development of surfaces at a specified non-right angle using a rotary table. Set up and establish hole locations in various relationships to one another using a rotary table. The holes are in the same plane. Establish the profile of a radius with respect to two surfaces and the connecting points of tangency.

Performance Standard: Given access to an appropriately sized rotary table, and accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications. The specified part will require two groups of holes arrayed on bolt circles, as well as several surfaces at various angles to one another.

- 6.1.3 Vertical Mill, Dividing Head Operations:** Set up and perform operations requiring a dividing head. Set up and establish hole locations in various relationships to one another using a dividing head. Establish the profile of a radius with respect to two surfaces and connecting points of tangency.

Performance Standard:

Given access to an appropriately sized dividing head and accessories, raw material, process plan, drawing, hand, precision, and cutting tools, produce a part matching the process plan and the drawing specifications. The specified part will require two groups of holes arrayed on an outer diameter, as well as several surfaces at various angles to one another.

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7.1 Module 7 Horizontal Milling Machine Operations

Designed for skill advancement in the operations of standard horizontal boring mill machines. Emphasis will be on tooling, adjustable boring heads, and precision boring operations. All work necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments is required.

- 7.1.1 Basic Horizontal Boring Mill Operations:** Set up and perform boring for location, size, and finish and mill a slot for location and size.

Performance Standard: Produce three bores, one with a tolerance of $\pm .002$ " counterbore, and one slot to specification.

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8.1 Module 8 Grinding Operations

Designed to provide skill advancement in the operations of standard surface and cylindrical grinding machines. Emphasis of this module will be on grinding wheel selection and preparation, and precision grinding practices for flats, angles, and straight diameters. All work necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments is required.

- 8.1.1 Surface Grinding, Finish Flats to $\pm .0005$ "**: Grind a block's six faces to finished dimensions having tolerances of $\pm .0005$ " and squareness of $.0005$ " over 4" and 32 micro inch surface finish. Dress the wheel as necessary.

Course Outline:

Performance Standard: Given a block squared up on a mill, hardened 55 to 60 Rockwell, and a process plan, drawing, hand and precision tools, a choice of grinding wheels, access to a surface grinder and accessories, dress the wheel, produce a part matching the process plan and the drawing specifications using proper trade practices. The part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

- 8.1.2 Surface Grinding, Finish Flats at Simple Angles:** Set up and perform the finish surface grinding of flat surfaces at simple angles with respect to one another. Dress the wheel as necessary.

Performance Standard: Given a block roughed out on a mill, a process plan, drawing, hand and precision tools, and choice of grinding wheels, as well as access to a surface grinder and accessories, dress the wheel, grind the specified angled surfaces to a finish matching the process plan and the drawing specifications using appropriate trade practices. The specified part would be in the semi-finished state having been roughed out. Finishing the part will require the precision finishing of the specified surfaces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

- 8.1.3 Grinding Wheel Preparation and Balancing:** Set up and perform the balancing operation of a 14" or greater diameter grinding wheel. Place the wheel into service.

Performance Standard: Given a wheel and appropriate equipment prepare the wheel to go into service. Mount the wheel. Produce a surface finish of 32 micro inches or better on a cylinder of CRS.

- 8.1.4 Cylindrical Grinding:** Set up and perform between centers grinding for straight diameters. Dress the wheel as necessary.

Performance Standard: Dress the wheel. Given a part rough finished on three diameters, mount the part between centers and grind the required diameters to finish.

15 10

9.1 Module 9 Radial Drill Operation

Designed to provide hands-on skill advancement in the operations of standard radial drills. Emphasis will be on drilling, reaming and power tapping. All practices necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments are required.

- 9.1.1 Drilling, Radial Drill:** Set up and perform drilling operations using a radial drill.

Performance Standard: Set up, centerdrill, drill, countersink, and tap a series of holes to drawing specification. Perform other operations as required by the drawing.

5 25

10.1 Module 10 Electro Discharge Machine (EDM)

Designed to introduce hands-on skill advancement in the operations of standard electro mechanical discharge plunge, and 2 axis wire EDM machines. Emphasis will be on the set up and operation of EDM machines. All practices necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments are required.

10.1.1 EDM, Operate a Plunge EDM: Operate a plunge electric discharge machine.

Performance Standard: Given a print, process plan, an appropriate selection of electrodes, work-holding devices, EDM fluids, and plunge EDM machine, perform the EDM operation called out on the process plan.

10.1.2 EDM, Operate a 2 Axis Wire EDM: Operate a 2 axis wire Electric Discharge Machine.

Performance Standard: Given a print, process plan, a selection of wire electrodes, work-holding devices, EDM fluids, and 2 axis wire EDM machine, perform the EDM operation called out on the process plan.

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11.1 Module 11 Computer Numerical Control Mill (CNC)

Designed to introduce hands-on skill advancement in the operations of standard CNC milling machines. Emphasis will be the introduction to CNC mill programming and CNC mill operation. All practices necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments are required.

11.1.1 CNC, Write Simple RS274-D Programs: Using a computer and editor software write simple RS274-D programs. Simple programs are single plane, cutter centerline, linear and circular interpolation, and single cutter, with no canned cycles.

Performance Standard: Given a drawing with the tool path shown, and computer with editor software, write a program, including speeds, feeds, depth of cuts, and coolant needs to drive an end mill through a continuous path around three sides of a part requiring the development of a linear interpolation tool path as well as circular interpolation. Store the program on computer media.

Course Outline:

11.1.2 CNC, Operate a CNC Milling Machine: Operate a CNC milling machine.

Performance Standard: Given a CNC mill with a qualified setup and functioning program, operate the mill, change tool values as necessary, replace and qualify tooling as necessary.

50 20

12.1 Module 12 CNC Turning Center Operations

Designed to introduce hands-on skill advancement in the operations of standard CNC turning center. Emphasis is on introduction to CNC turning center programming and operation. All practices necessary to produce a part given raw material, process plan, drawing, tooling, and measuring instruments are required.

12.1.1 CNC, Write Simple RS272-D Programs: Using a computer and editor software write simple RS274-D programs. Simple programs are single plane, cutter centerline, linear and circular interpolation, and single cutter, with no canned cycles.

Performance Standard: Given a drawing with the tool path shown, and computer with editor software, write a program, including speeds and feeds, depth of cuts and coolant needs, to drive a cutting tool through a continuous path to produce a part requiring the development of a linear interpolation tool path as well as circular interpolation. Store the program on computer media.

12.1.2 CNC, Operate a CNC Turning Center: Operate a CNC turning center.

Performance Standard: Given a CNC turning center with a qualified setup and functioning program, operate the turning center, change tool values as necessary, replace and qualify tooling as necessary.

13.1 Module 13 Industry Experience

Expand skill levels working in a machining/manufacturing environment utilizing cooperative education and/or community classroom methodologies.

360 180

Level II Classroom Hours: 360

Level II Industry Hours: 180

Total Level II Course Hours 540

Total NIMS Precision Machining Course Hours 1080